Intelligent Planning as KaaS for Emergency and Convergent Domains

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ABSTRACT
In this paper we describe ongoing work exploring the use of the interactive Digital TV (iDTV) platform for designing and building solutions for emergency and convergent domains based on Artificial Intelligence (AI) Planning.

Author Keywords
Interactive Digital TV; Knowledge Representation; AI Planning; Emergency Domains.

ACM Classification Keywords
D.2.11 Software Architectures; H.5.1 Multimedia Information Systems; I.2.4 Knowledge Representation Formalisms and Methods; I.2.8 Problem Solving, Control Methods, and Search

INTRODUCTION

Effective management of events in emergency situations is a challenge for modern society. Emergency Management [1] includes planning, action taken during a crisis and recovery actions. In this ongoing work we investigate the use of Artificial Intelligence Planning [2] technology, incorporated to a convergent environment of interactive Digital TV – iDTV [3], mobile and Web platforms, to give support in emergency management situations.

Knowledge-Based Systems, in particular Artificial Intelligence Planning [2], may fulfill some of the requirements of the Emergency Management domain. It gives support to knowledge engineering capabilities for domain specification and permits automated reasoning in the search for a course of action to be performed in an emergency crisis, when the search space for a solution to the problem is too large to be managed by human agents only, and also when there are time restrictions, since actions should be taken quickly to minimize the impact of the crisis.

On the other hand, emergency domains can benefit from a systems architecture based on a convergent environment (iDTV, mobile and Web platforms) approach, since it gives support to collaborative knowledge engineering, planning and execution, and mixed-initiative collaboration.

To build such a convergent environment, we investigate the use of the Knowledge-as-a-Service (KaaS) paradigm [4], which was proposed as a form to extend the potential of computational systems developed as DaaS [5] and SaaS [6]. Two main advantages of this paradigm can be stressed. First, the models used by this paradigm are based on formal semantic representations, so that we do not have the same problems that are found in DaaS or SaaS. Second, the knowledge servers have the capacity of accessing data from different sources, instantiating their representations and generating knowledge to be delivered via intelligent processes such as Data Mining algorithms. In the work presented in this paper on Intelligent Planning as KaaS for emergency and convergent domains it is intended to push the KaaS paradigm forward by broadening the types of knowledge-based systems used to build service-oriented architectures.

Hence, this work investigates representational approaches for KaaS, which enable an appropriate semantic description for data that comes from different platforms. Our aim is to use the KaaS metaphor as a form to enable convergence among different computational platforms, such as the iDTV and Web or mobile platforms. We argue that the integration of data from different platforms can be very useful to extend the services that are running on a specific platform, and especially for emergency management domains. In brief, this work focuses on KaaS models and algorithms; knowledge engineering and automated reasoning supported by AI Planning, applied to emergency situations.

KAAS FOR CONVERGENT ENVIRONMENTS

Knowledge-as-a-Service (KaaS) [4] is a service-oriented computational paradigm where a knowledge-based service provider, or knowledge service, answers requests sent by information consumers. These services are based on knowledge models that are in general expensive or impossible to be maintained by the consumers. Figure 1 shows a conceptual view of services, according to the KaaS approach.

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According to this figure, the framework defined for KaaS has three logic components [4]: (1) data providers, (2) knowledge server (knowledge extractor and processing algorithms) and (3) knowledge consumers.

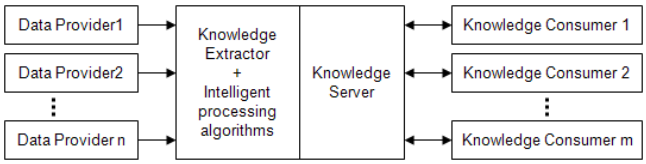

Figure 1 - KaaS conceptual view [4]

This research investigates how such components should be instantiated, according to our approach. It is important to highlight three essential features of KaaS, which makes this computational paradigm appropriate for the configuration of convergence environments:

- KaaSs are based on formal semantic models, for instance ontologies, which enable standardization of format and meaning. Thus, knowledge can be shared among participants that adopt a specific model;
- KaaSs act like consolidation components, since they can seek information to instantiate their models, transforming that information into knowledge;
- The intelligent processes used in Web servers, such as Data Mining algorithms, can emphasize knowledge originally implicit or impossible to be derived from primary data sources due to the weakness and informality of their representations.

Such KaaS features have been explored and evolved as a research topic with its own discussion forum (*Workshop on Knowledge as a Service*[1], part of *IEEE International Conference on Computer Science and Service System* - CSSS 2012). Interesting approaches to this research area have been explored recently.

PLANNING FOR EMMERGENCE RESPONSE

In [1] the use of shared procedural knowledge for virtual collaboration support in emergency response is described. The approach consists of a dynamic website and a 3D virtual meeting space supported by an underlying AI planning framework. The underling <I-N-C-A> ontology is based on principles of Hierarchical Task Networks (HTN) [7] planning, which provides a "natural" way to decompose tasks into subtasks. The <I-N-C-A> representation consists of a set of *issues* to be addressed in a plan, a set of *nodes* that corresponds to the activity network, a set of *constraints* on their performance and a set of *annotations* to hold information about the plan's rationale and other elements.

[1] http://www.cssconf.org/2012/kaas

The general <I-N-C-A> framework has been applied, tested and validated in many scenarios.

INTERACTIVE DIGITAL TV INTELLIGENT RESPONSE TO EMERGENCY SCENARIOS USING COLLABORATIVE AI PLANNING

This ongoing work has investigated how the iDTV platform and its *interactive* feature can be used to support emergency scenarios in different phases of Emergency Management. The approach explored is based on collaborative planning for: task support, situation awareness, environment sensing and scenario update. Possible user roles on the iDTV platform are home users in a crisis situation or Emergency Management personnel in live operations or simulation and training activities; where it is important that the identification of how convergent iDTV platform features can meet the application and user needs. Initially, the project is defining the knowledge representation needs for an intelligent response to emergence scenarios and what are the planning aspects challenges, such as, coordination, information sharing and overlaps in response procedures and plans.

CONCLUSION

This paper presented work that is being carried out regarding the investigation of a planning framework to be used as the underlying intelligent processing algorithm in a KaaS approach for supporting a convergent (iDTV, Web and mobile) environment for emergency domains. The project initially defined the convergent emergency scenario requirements. In addition, an architecture and model have been defined to expand the application of knowledge-based service systems.

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REFERENCES

1. Wickler, G., Tate, A. and Hansberger, J. (2013), Using Shared Procedural Knowledge for Virtual Collaboration Support in Emergency Response, in Special Issue on Emergency Response, IEEE Intelligent Systems, Vol. 28, No. 4, July/August 2013, IEEE Computer Society.
2. Ghallab, M., Nau, D. and Traverso P. (2004) Automated Planning: Theory and Practice. Morgan Kaufman
3. P. Cesar and K. Chorianopoulos, "Interactive Digital Television and Multimedia Systems," Proceedings of the ACM Multimedia Conference, Santa Barbara, California, USA, October 23-27, 2006, p. 7-7

4. Xu, S., and Zhang, W. 2005. Knowledge as a Service and Knowledge Breaching. *Proceedings of 2005 IEEE International Conference on Services Computing*, vol. 1, pp: 87-94, Orlando, Florida, USA.
5. Wang, X., Vitvar, T., Kerrigan, M., and Toma, I. 2006. A QoSs-aware selection model for semantic web services. *Lecture Notes in Computer Science*, A. Dan and W. Lamersdorf, Eds., vol. 4294. Springer, pp. 390–401.
6. Turner, M. *et al*. 2003. Turning software into a service. *Computer*, 36(10):38-44.
7. Tate, A. (2003) <I-N-C-A>: a Shared Model for Mixed-initiative Synthesis Tasks, Proceedings of the Workshop on Mixed-Initiative Intelligent Systems (MIIS) at the International Joint Conference on Artificial Intelligence (IJCAI-03), pp. 125-130, Acapulco, Mexico, August, 2003.